



116

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Lignin

STAGE I

Base-catalyzed
depolymerization
(BCD)

Medium: water
Catalysts: (a) dilute (1 - 5 wt%) aqueous NaOH; (b) solid superbase (e.g., CsX-type zeolite); or (c) combinations of (a) and (b)
Temperature, °C: 300 - 340



Depolymerized lignin
(mixture of alkylated phenols, alkoxybenzenes, and
alkoxyphenols; and hydrocarbons)

STAGE II

Single-step
hydroprocessing (HPR),
comprising simultaneous
(a) exhaustive hydrodeoxygenation (HDO); and (b)
mild hydrocracking (HCR)

Sulfided co-catalyst systems:
(a) MMo/Al₂O₃ plus
(b) MMo/SiO₂-Al₂O₃-zeolite
where M (promoter) = Ru, Re, Co,
Fe, Cr, Pt or other VI - VIII group
metals; and combinations thereof
Temperature, °C: 350 - 390
No solvent



$C_7 - C_{10}$ alkylbenzenes (approx. 80-90 wt%);
 $C_5 - C_{10}$ branched paraffins plus $C_6 - C_{10}$ alkylated
naphthenes (approx. 10 - 20 wt%)

Figure 1a Schematic flow diagram of the two-stage (BCD-HPR) process for conversion of lignin to $C_7 - C_{10}$ alkylbenzenes as gasoline blending components according to the present invention.

Process Concept for Converting Lignin into High-Octane Fuel Additive

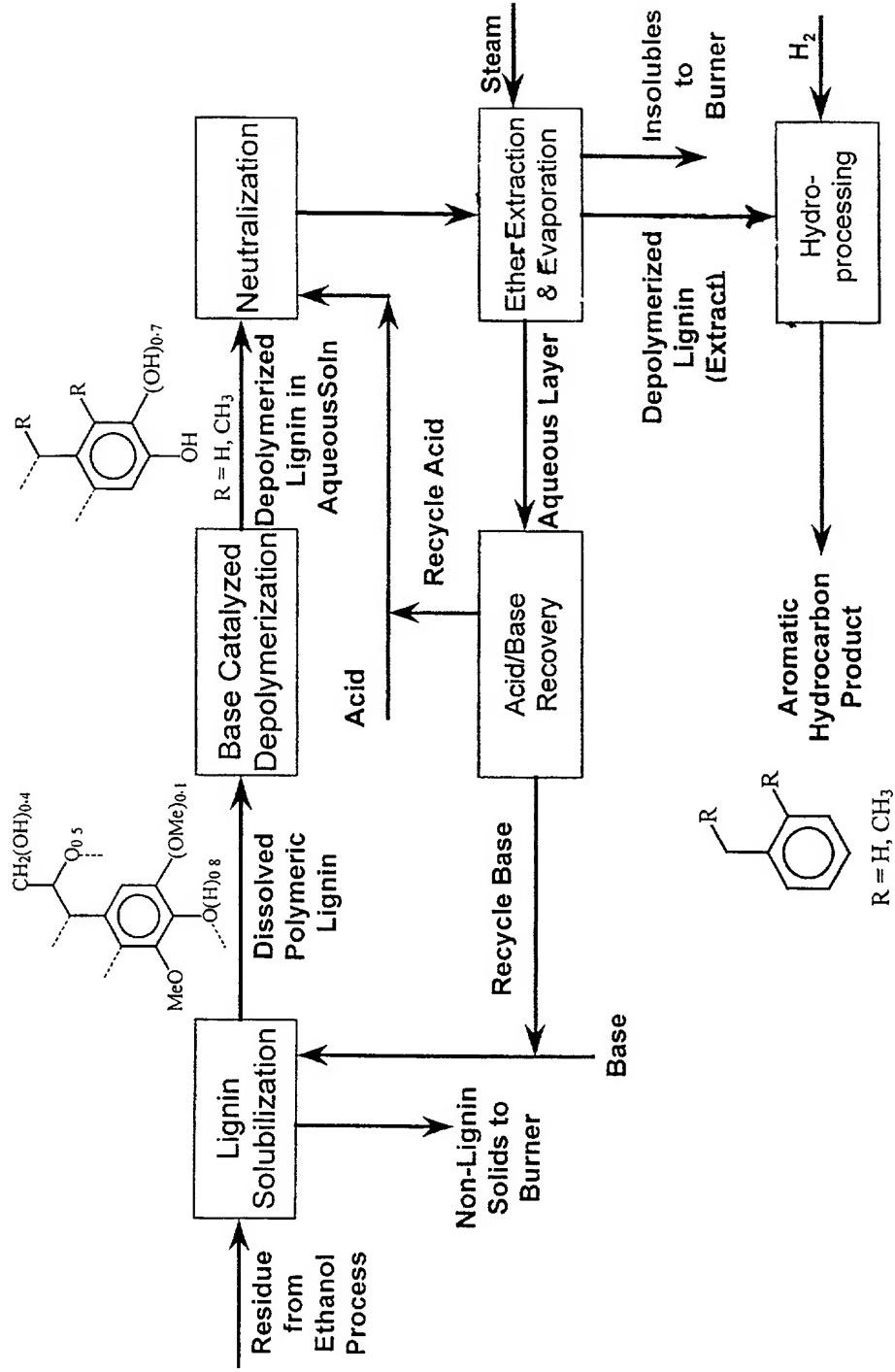


Figure 1b

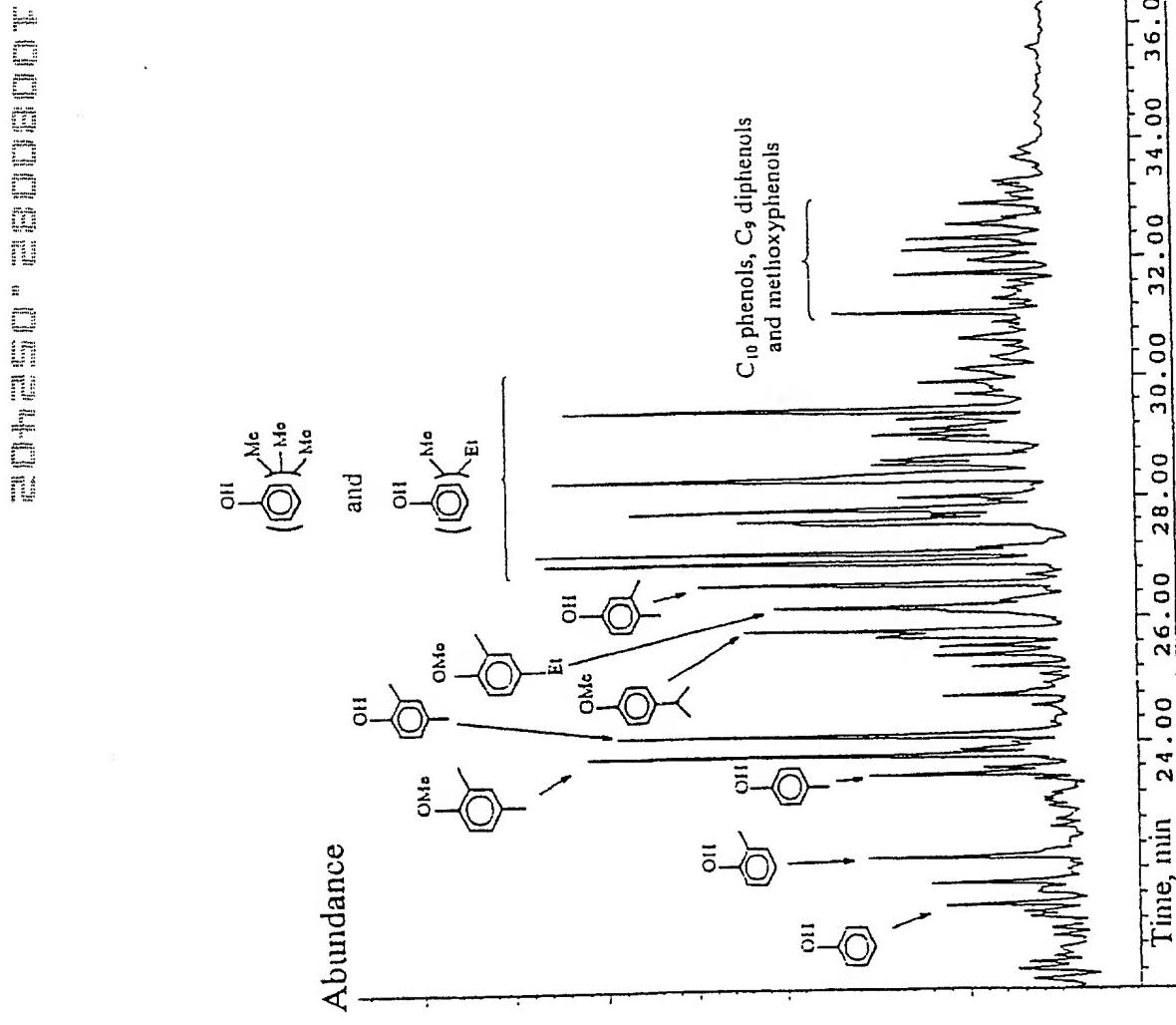


Figure 2. Example of GC/MS analysis of depolymerized (BCD) product from Repap lignin.

4/6

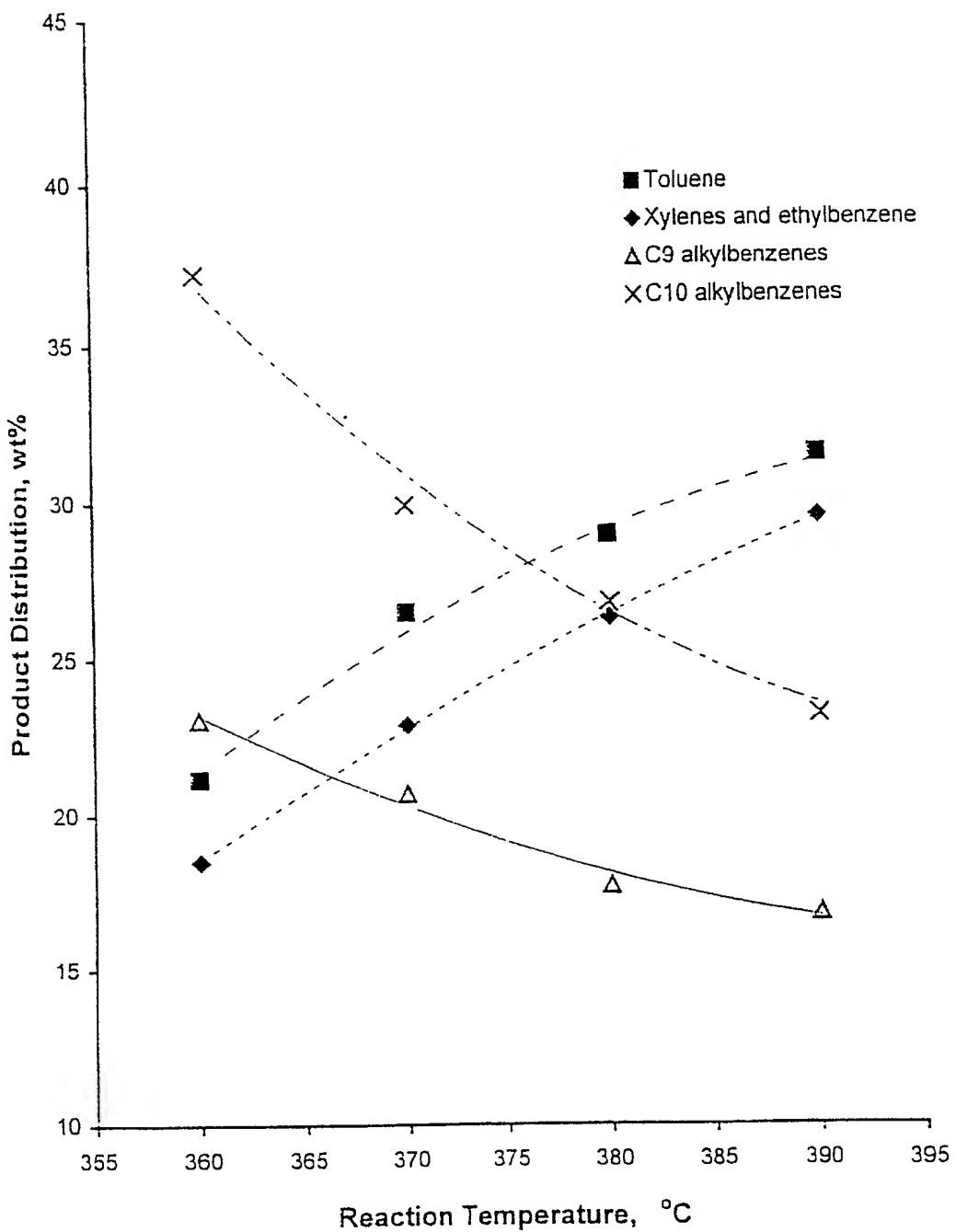


Figure 3. Change in Composition of C_7 - C_{10} Alkylbenzene Products from BCD-HPR of Repap Lignin, as a Function of HPR Reaction Temperature

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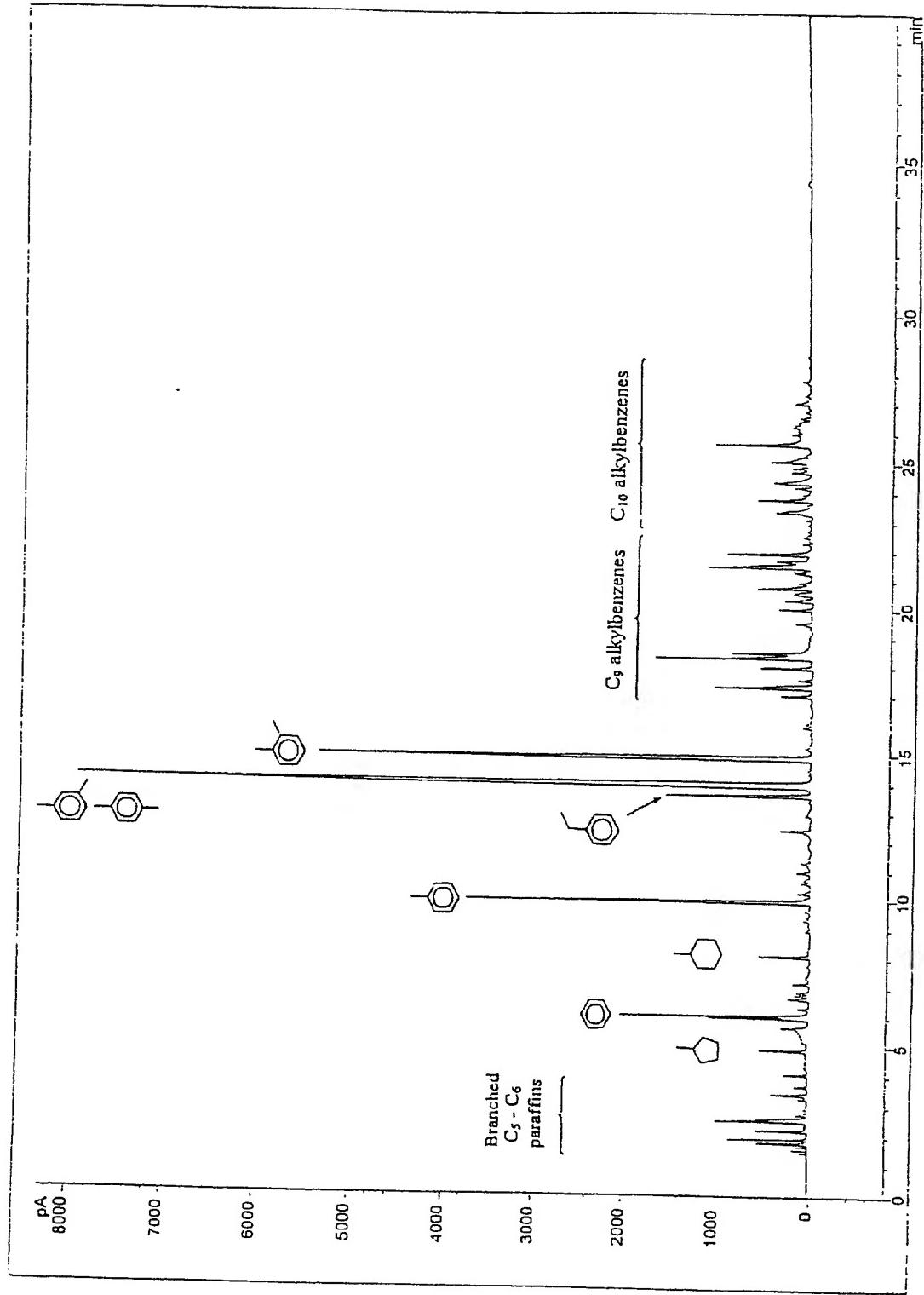


Figure 4. Example of GC/MS analysis of HPR product from depolymerized Repap lignin (HPR temperature, 380 °C; H₂ pressure, 500 psig; LHSV = 4 h⁻¹; HCR/HDO co-catalyst wt. ratio, 1 : 9).

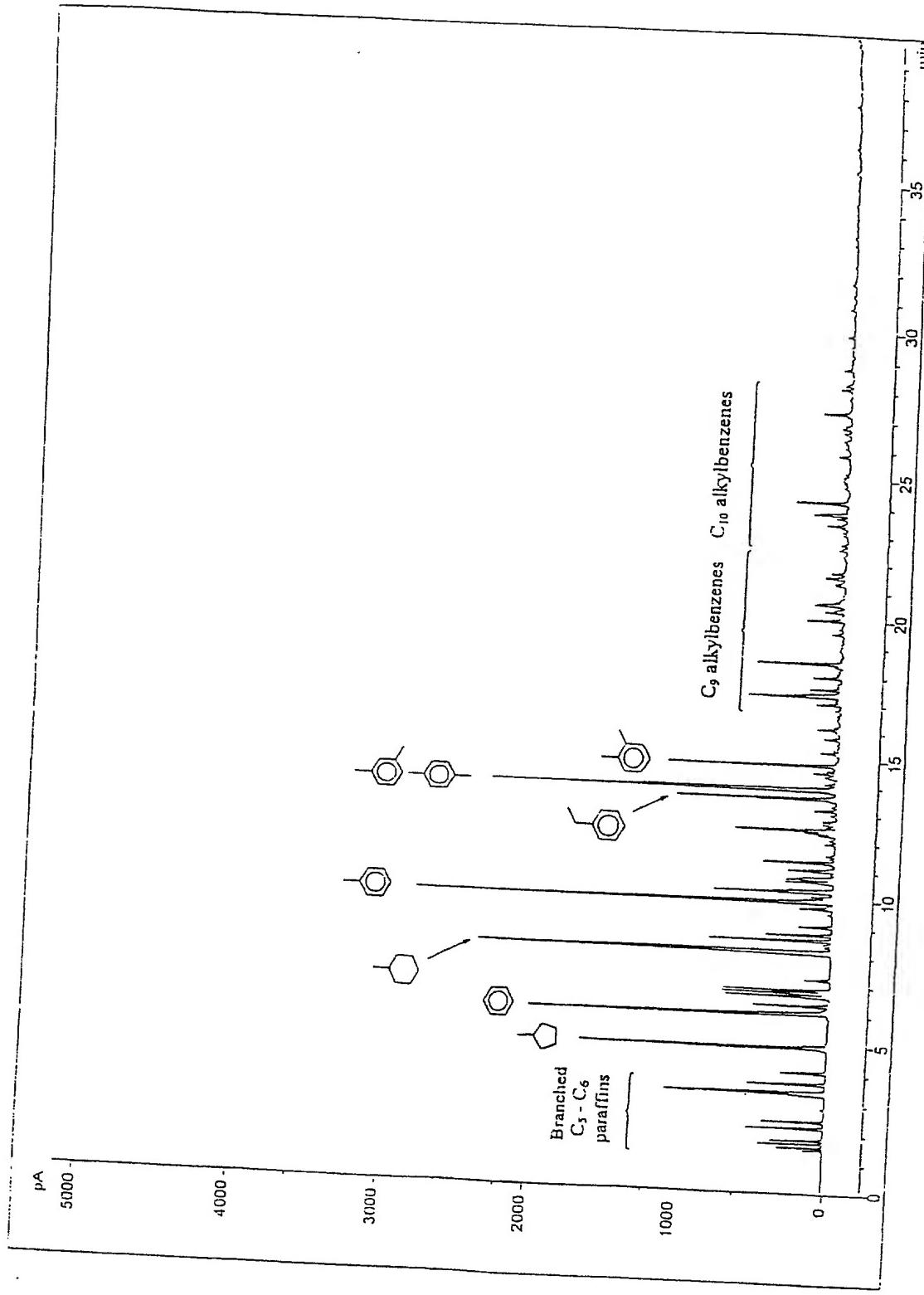


Figure 5. Example of GC/MS analysis of HPR product from depolymerized Repap lignin (HPR temperature, 380 °C; H₂ pressure, 1500 psig; LHSV = 4 h⁻¹; HCR/HDO co-catalyst wt. ratio, 1 : 4).